(54) Title: INTAKE SYSTEMS FOR PERSONAL CARE PRODUCTS

(57) Abstract: There is provided an intake system material for personal care products made from a nonwoven web and having a hydrophobic top surface and a capillary tension gradient which increases in the Z-direction perpendicular to the top surface. The intake system material may be made from a single layer or multiple layers and useful in personal care products like diapers, training pants, incontinence garments and feminine hygiene products.

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INTAKE SYSTEMS FOR PERSONAL CARE PRODUCTS

FIELD OF THE INVENTION

5   The present invention relates to intake systems mainly for personal care products like diapers, training pants, swim wear, absorbent underpants, adult incontinence products and feminine hygiene products. This material may also be used other applications such as, for example, in bandages and wound dressings, nursing pads and veterinary applications.

10   ## BACKGROUND OF THE INVENTION

          Personal care articles, such as diapers, typically are composed of multiple components including the liner, absorbent core, and baffle (also called a backsheet) The liner in conjunction with an absorbent layer(s) often must deliver softness and comfort,
15   visual distinctiveness, absorbency, cleanliness, and dryness.
          The liner is sometimes referred to as a bodyside liner or topsheet. In the thickness direction of the article, the liner material is the layer against the wearer's skin and so the first layer in contact with liquid or other exudate from the wearer. The liner further serves to isolate the wearer's skin from the liquids held in an absorbent structure and should be
20   compliant, soft feeling and non-irritating.
          Previous materials used as liners have been light weight, single layer structures of fine fibers in order to be cost efficient and provide good appearance. They have usually been treated with surface chemistries (i.e. surfactants) to improve liquid intake, though some fibers are inherently hydrophilic. Surfactants change the surface tension on the
25   web causing the web to become hydrophilic so that liquid will "wet out" or spread across the surface of the web. This wetting action leaves the liner saturated, prolonging liquid contact with the skin and increasing skin hydration. It is desirable, however, that personal care articles be designed so as to minimize skin hydration since skin hydration contributes to the occurrence of diaper rash in diaper applications, for example. If the liner has poor
30   liquid intake qualities, remains saturated, or has fluid spreading properties, skin hydration will be increased.

Newer product designs incorporate one or more layers of material to help prevent leakage. This layer may act as a very temporary storage area, distribution medium, or both. This layer below the liner layer, called the "surge" layer here, has previously been a relatively high permeability material so that liquid could pass quickly through to the absorbent core. Passing liquid quickly through to the absorbent core, however, results in a large mass of fluid accumulated in the target area, leaving much of the absorbent core unused, and excessively hydrating the target or crotch area.

There remains a need, therefore, for an intake system that will have good intake properties, low saturation, minimal fluid spreading on the surface yet utilize more of the absorbent core, and that will reduce skin hydration, and diaper rash accordingly. It is an object of this invention to provide such an intake system.

SUMMARY OF THE INVENTION

The object of the invention is achieved by an intake system material for personal care products where the top or wearer-facing surface of the material is hydrophobic (or has a liquid contact angle of 90 degrees or greater), and the capillary tension of the material increases in the Z-direction away from the wearer surface. The material may be a single layer or may be made from multiple layers, and may be treated with surfactants internally or topically.

DEFINITIONS

"Disposable" includes being disposed of after a single use and not intended to be washed and reused.

"Front" and "back" are used throughout this description to designate relationships relative to the garment itself, rather than to suggest any position the garment assumes when it is positioned on a wearer. The Y-direction is the direction from front to back of a product, the Z-direction is perpendicular to the Y-direction and is into the product, and the X direction is perpendicular to both the Y and Z directions.

"Liquid communication" means that liquid is able to travel from one layer to another layer, or one location to another within a layer.

"Hydrophilic" describes fibers or the surfaces of fibers that are wetted by the aqueous liquids in contact with the fibers. The degree of wetting of the materials can, in turn, be described in terms of the contact angles and the surface tensions of the liquids

and materials involved. Equipment and techniques suitable for measuring the wettability of particular fiber materials can be provided by a Cahn SFA-222 Surface Force Analyzer System, or a substantially equivalent system. When measured with this system, fibers having contact angles less than 90° are designated "wettable" or hydrophilic, while fibers

5   having contact angles equal to or greater than to 90° are designated "nonwettable" or hydrophobic.

As used herein the term "nonwoven fabric or web" means a web having a structure of individual fibers or threads which are interlaid, but not in an identifiable manner as in a knitted fabric.   Nonwoven fabrics or webs have been formed from many processes such as

10 for example, meltblowing processes, spunbonding processes, and bonded carded web processes. The basis weight of nonwoven fabrics is usually expressed in ounces of material per square yard (osy) or grams per square meter (gsm) and the fiber diameters useful are usually expressed in microns. (Note that to convert from osy to gsm, multiply osy by 33.91).

15 "Spunbonded fibers" refers to small diameter fibers that are formed by extruding molten thermoplastic material as filaments from a plurality of fine capillaries of a spinneret. Such a process is disclosed in, for example, US Patent 4,340,563 to Appel et al. The fibers may also have shapes such as those described, for example, in US Patents 5,277,976 to Hogle et al. which describes fibers with unconventional shapes.

20 "Bonded carded web" refers to webs that are made from staple fibers which are sent through a combing or carding unit, which separates or breaks apart and aligns the staple fibers in the machine direction to form a generally machine direction-oriented fibrous nonwoven web. This material may be bonded together by methods that include point bonding, through air bonding, ultrasonic bonding, adhesive bonding, etc.

25 "Airlaying"is a well-known process by which a fibrous nonwoven layer can be formed. In the airlaying process, bundles of small fibers having typical lengths ranging from about 3 to about 52 millimeters (mm) are separated and entrained in an air supply and then deposited onto a forming screen, usually with the assistance of a vacuum supply. The randomly deposited fibers then are bonded to one another using, for

30 example, hot air or a spray adhesive. Airlaying is taught in, for example, US Patent 4,640,810 to Laursen et al.

As used herein "thermal point bonding" involves passing a fabric or web of fibers to be bonded between a heated calender roll and an anvil roll. The calender roll is usually, though not always, patterned in some way so that the entire fabric is not bonded across its

35 entire surface, and the anvil roll is usually flat. As a result, various patterns for calender rolls have been developed for functional as well as aesthetic reasons. One example of a pattern

has points and is the Hansen Pennings or "H&P" pattern with about a 30% bond area with about 200 bonds/square inch as taught in U.S. Patent 3,855,046 to Hansen and Pennings. The H&P pattern has square point or pin bonding areas wherein each pin has a side dimension of 0.038 inches (0.965 mm), a spacing of 0.070 inches (1.778 mm) between pins,

5 and a depth of bonding of 0.023 inches (0.584 mm). The resulting pattern has a bonded area of about 29.5%. Another typical point bonding pattern is the expanded Hansen Pennings or "EHP" bond pattern which produces a 15% bond area with a square pin having a side dimension of 0.037 inches (0.94 mm), a pin spacing of 0.097 inches (2.464 mm) and a depth of 0.039 inches (0.991 mm). Other common patterns include a diamond pattern

10 with repeating and slightly offset diamonds with about a 16% bond area and a wire weave pattern looking as the name suggests, e.g. like a window screen, with about a 19% bond area. Yet another common pattern is the C-Star pattern which has a bond area of about 16.9%. The C-Star pattern has a cross-directional bar or "corduroy" design interrupted by shooting stars. Typically, the percent bonding area varies from around 10% to around 30%

15 of the area of the fabric laminate web. As in well known in the art, the spot bonding holds the laminate layers together as well as imparts integrity to each individual layer by bonding filaments and/or fibers within each layer.

Various processes are known for the bonding of nonwoven webs. These include through air bonding, stitchbonding, ultrasonic bonding, point bonding, and pattern (or

20 point) unbonding. Examples of these bonding processes may be seen in US Patents 4,891,957 to Strack et al., 4,374,888 to Bornslaeger, 3,855,046 to Hansen and Pennings, and 5,858,515 to Stokes et al.

"Personal care product" means diapers, training pants, swim wear, absorbent underpants, adult incontinence products, bandages and feminine hygiene products.

25 "Target area" refers to the area or position on a personal care product where an insult is normally delivered by a wearer.

TEST METHODS AND MATERIALS

30 Basis Weight: A circular sample of 3 inches (7.6 cm) diameter is cut and weighed using a balance. Weight is recorded in grams. The weight is divided by the sample area. Five samples are measured and averaged.

Material caliper (thickness): The caliper of a material is a measure of thickness and is measured at 0.05 psi (3.5 g/cm^2) with a STARRET®-type bulk tester, in units of

35 millimeters. Samples are cut into 4 inch by 4 inch (10.2 cm by 10.2 cm) squares and five samples are tested and the results averaged.

Density: The density of the materials is calculated by dividing the weight per unit area of a sample in grams per square meter (gsm) by the material caliper in millimeters (mm). The caliper should be measured at 0.05 psi (3.5 g/cm^2) as mentioned above. The result is multiplied by 0.001 to convert the value to grams per cubic centimeter (g/cc). A

5 total of five samples would be evaluated and averaged for the density values.

Permeability: Permeability is obtained from a measurement of the resistance by the material to the flow of liquid. A liquid of known viscosity is forced through the material of a given thickness at a constant flow rate and the resistance to flow, measured as a pressure drop is monitored. Darcy's Law is used to determine permeability as follows:

10 Permeability = [flow rate x thickness x viscosity / pressure drop]   [Equation 1]

where the units are:

permeability:	cm^2 or Darcy	1 Darcy = 9.87 x 10^{-9} cm^2
flow rate:	cm/sec	
viscosity:	Pascal-sec	
15 pressure drop:	Pascals	

The apparatus consists of an arrangement wherein a piston within a cylinder pushes liquid through the sample to be measured. The sample is clamped between two aluminum cylinders with the cylinders oriented vertically. Both cylinders have an outside

20 diameter of 3.5 inches (8.9 cm), an inside diameter of 2.5 inches (6.35 cm) and a length of about 6 inches (15.2 cm). The 3 inch diameter web sample is held in place by its outer edges and hence is completely contained within the apparatus. The bottom cylinder has a piston that is capable of moving vertically within the cylinder at a constant velocity and is connected to a pressure transducer that is capable of monitoring the pressure

25 encountered by a column of liquid supported by the piston. The transducer is positioned to travel with the piston such that there is no additional pressure measured until the liquid column contacts the sample and is pushed through it. At this point, the additional pressure measured is due to the resistance of the material to liquid flow through it. The piston is moved by a slide assembly that is driven by a stepper motor. The test starts by moving

30 the piston at a constant velocity until the liquid is pushed through the sample. The piston is then halted and the baseline pressure is noted. This corrects for sample buoyancy effects. The movement is then resumed for a time adequate to measure the new pressure. The difference between the two pressures is the pressure due to the resistance of the material to liquid flow and is the pressure drop used in Equation (1). The velocity of

35 the piston is the flow rate. Any liquid whose viscosity is known can be used, although a liquid that wets the material is preferred since this ensures that saturated flow is achieved.

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The measurements were carried out using a piston velocity of 20 cm/min, mineral oil (Peneteck Technical Mineral Oil manufactured by Penreco of Los Angeles, CA) of a viscosity of 6 centipoise.

Conductance: This is calculated as permeability per unit thickness and gives a
5 measure of the openness of a particular structure and so an indication of the relative ease at which a material will transmit liquid.

TransEpidermal Water Loss (TEWL):

Skin hydration values are determined by measuring TransEpidermal Water Loss (TEWL) and can be determined by employing the following test procedure.

10 The test is conducted on adults on the forearm. Any medications should be reviewed to ensure they have no effect on test results and the subject's forearms should be free of any skin conditions such as rashes or abrasions. Subjects should relax in the test environment, which should be at about 72°F (22 °C) with a humidity of about 40 percent, for about 15 minutes prior to testing and movement should be kept to a minimum
15 during testing. Subjects should wear short sleeve shirts, not bathe or shower for about 2 hours before testing, and should not apply any perfumes, lotions, powders, etc., to the forearm.

The measurements are taken with an evaporimeter, such as a DERMALAB® instrument distributed by Cortex Technology, Textilvaenget 1 9560 Hadsund Denmark.

20 A baseline reading should be taken on the subject's forearm and should be less than 10 g/m^2/hr. Each test measurement is taken over a period of two minutes with TEWL values taken once per second (a total of 120 TEWL values). The digital output from the Evaporimeter EP1 instrument gives the rate of evaporative water loss (TEWL) in g/m^2/hr.

25 The end of a dispensing tube is placed on the mid-forearm for carrying out the test. The eye of the tube should be facing the target loading zone. A product to be tested is placed on the subject's forearm directly over the end of the tube. The product may vary depending upon the type of material to be tested or material availability so care should be taken to ensure that test results are comparable. A stretchable net such as that available
30 from Zens Industrial Knit Products of Milwaukee, WI, should be placed over the product to help to hold it in place.

Three equal loadings of 70 ml of physiologic saline available from VWR Scientific Products (800-932-5000) at about 95 °F (35 °C) are delivered to the product at an interval of 45 seconds at a rate of 300 mils/minute by a pump such as a MASTERFLEX® Digi-
35 Static batch/dispense pump. After 60 minutes, the product is removed from the subject's forearm and Evaporimeter readings taken immediately on the skin where the product had

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been.

TransEpidermal Water Loss values are reported as the difference between the one hour and baseline values in g/m²/hr.

Capillarity: Capillarity is defined as the tendency of liquids to be absorbed by and held within a porous structure. This tendency, expressed as capillary tension, is measured according to an adaptation of the porous plate method reported by Burgeni and Kapur in The Textile and Research Journal, Volume 37 (May 1967), p. 356 – 366. The method consists in counterbalancing the capillary pressure with an equal but opposite hydrostatic tension (h) and simultaneously determining the amount of liquid the sample gains or loses as the hydrostatic tension is lowered or raised. In addition to measuring the liquid content of the sample at various hydrostatic tensions, the apparatus is designed to measure the simultaneous changes in the bulk volume of the fiber mass.

The test apparatus consists of a UNISLIDE® vertically moving platform having graduated height indication and a programmable stepper motor, a funnel and filter plate assembly, a fluid reservoir and some tubing, and an electronic balance controlled by a microprocessor. Placed on the UNISLIDE® platform is the funnel having inside it a horizontal filter plate of known pore size. The bottom of the funnel is attached with TYGON® tubing to a fluid reservoir resting on the electronic balance and the reservoir, tubing and funnel (to the bottom of the filter plate) are filled with fluid. The UNISLIDE® platform used herein was made by Velmex Inc. of Bloomfield, NY and was model no. MB4045P10J-S4. The funnel and filter plate unit was made by Pyrex Corp. with model no. 36060, and the filter plate had pores of 10-15 microns.

The pore size is calculated from LaPlace's equation (Equation 2) which relates hydrostatic tension or height (h), to pore size and wettability, which is expressed as contact angle.

$$h = 2\,\gamma\ \text{Cos}(\theta)\,/\,(\rho_l\ g\ r) \qquad\qquad\qquad \text{[Equation 2]}$$

where:

h = height, in cm

γ = surface tension of liquid used, in dynes/cm

θ = contact angle, in degrees

ρ_l = liquid density, in g/cc

g = gravitational constant, 980.665 cm/sec²

r = pore size, in cm

Hence, there is a correspondence between equivalent pore size and height.

A control program moves the platform to the desired height, collects data at a specified sampling rate until equilibrium is reached, and then moves to the next

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calculated height corresponding to the next pore size. Controllable parameters include sampling rates, criteria for equilibrium and the number of absorption/desorption cycles. The filter plate is filled with liquid so that an uninterrupted column of liquid extends from the lower face of the filter plate into the capillary tubing and to the reservoir. If a dry

5   sample of the absorbent materials is placed on top of the filter plate, liquid will be sucked into the pore system. The fill-up of the pore system will depend upon the height of the filter plate above the level of the reservoir or, in other words, upon the hydrostatic tension under which absorption occurs. The device, therefore, can be used to raise or lower in small steps the hydrostatic tension under which sorption occurs. The simultaneous take-

10   up or loss of water is determined by measuring the amount of liquid remaining in the reservoir. The capillary attraction of an absorbent medium, thus, can be characterized in terms of the pore fill-up under systematically varied conditions of hydrostatic tension.

In the testing procedure, the sample of known weight is placed on the porous filter plate on the UNISLIDE® platform. A typical sample size is 3 inches in diameter. On top

15   of the sample is placed a small, 47 gram plastic disk to hold the sample in place. The plastic disk has 57 pins to distribute its weight so that the sample is not collapsed, so each pin carries 0.82 grams of weight. Liquid is supplied to the filter plate from the reservoir on the electronic balance and the system is allowed to equilibrate. By lowering the filter plate, the hydrostatic tension head h is then reduced step by step in predetermined

20   intervals. The intervals are chosen to be equally spaced equivalent pore sizes (e.g. from 20 microns to 520 microns at 20 micron intervals) The sample thus begins to absorb fluid, and this is reflected in a reduction of the reservoir volume and weight. At each value of pore size or h, the system is permitted to equilibrate. When no further reduction is noticeable, the reservoir weight is recorded and the web thickness measured. The

25   procedure is repeated until the largest pore size is scanned (h is almost zero), and in this manner, the amount of sorbed fluid at each pore size is determined. At this stage, the sample has gone from the state of dryness to one of complete saturation. The process may be reversed by raising the filter plate by means of the UNISLIDE® platform step-by-step in predetermined height intervals. The resulting increase in hydrostatic tension

30   causes fluid to be drained out of the web. The sorption cycle may then be repeated.

Plotting the volume of liquid absorbed or desorbed at each height versus the pore size yields the pore size distribution of the sample. The peak in the distribution is designated as the mode pore size and is the pore size that contains the most liquid. When the liquid used is a liquid that totally wets the sample, the pore size distribution reflects the

35   structure of the sample. Typical liquids used are hexadecane, mineral oil, or aqueous surfactant solutions. If the wettability or contact angle of the sample is known, the

capillarity of the structure can be calculated using Equation 2.

In cases where the wettability or contact angle of the sample is not known, it can be derived by determining the mode pore size of the sample using a totally wetting liquid and then determining the mode pore size of the sample using water. In both cases, the apparatus scans the sample using pore sizes calculated assuming total wetting. The mode pore size of the sample using water will be identical to the mode pore size of the totally wetting fluid if the sample is totally wetted by water, and will be shifted towards larger pore sizes if it was only partially wetted. The ratio of mode pore size in the wetting fluid to the mode pore size in water represents the wettability of the sample and is equal to the cosine of the contact angle.

$$Cos(\theta) = (Mode\ pore\ size)_{wetting\ fluid}/(Mode\ pore\ size)_{water}$$

This value is then used in Equation 2 to determine the capillarity of the sample.

The first desorption cycle has been used in all the determinations for capillarity.

Horizontal Wicking: This test measures how far liquid will move in a fabric when only one end of the fabric is immersed in the liquid and the fabric is horizontal. The fabric to be tested is prepared by cutting it into 1 inch (2.5 cm) by 8 inch (20.3 cm) strips in the machine direction. The fabric is compressed to a thickness of 0.06 inches (1.52 mm) by any suitable means. The sample is weighed and marked every 0.5 inch (13 mm) in the long dimension. The sample is placed on a 5 inch (12.7 cm) by 10 inch (25.4 cm) horizontal wire grid and slightly weighted so that it remains flat on the wire. A half inch of one end of the sample is submerged in a 0.5 inch deep by 0.5 inch wide by 5 inch long reservoir containing 10 ml of dyed 8.5 g/l saline solution.   The end of the sample in the reservoir is held in place with a cylindrical glass stirring rod having a length of 1.5 inches (3.8 cm) and a diameter of 5/16 inches (7.9 mm) which also is submerged in the saline solution. The sample is allowed to rest with one end submerged in the reservoir for 20 minutes and is then carefully pulled horizontally out of the reservoir, cut at each 0.5 inch mark and each section weighed.

The dry sample weight is subtracted from the wet sample weight to arrive at fluid grams, and the 0.5 inch submerged in the reservoir is not considered. The total distance wicked is recorded along with the total grams of fluid wicked.

DETAILED DESCRIPTION OF THE INVENTION

This invention relates to an intake system used in an absorbent article to provide enhanced skin dryness. This intake system consists of a material which may contain one or more layers.

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The surface of the intake system material should have intake properties such that the incoming liquid stream is quickly transported into the material and hence, minimal pooling of the liquid at the top surface occurs. Additionally, the top of the system material should have minimal saturation so that the skin hydration is not increased. This can be

5   accomplished by providing a structure that desirably has a capillary tension that is zero or negative. Another way of expressing this desire is to say that the contact angle of the surface should be 90 degrees or greater or that the surface should be hydrophobic.

A hydrophobic surface will not wick liquid along the fibers but instead hold it in one place in, for example, the form of a droplet, until sufficient pressure is exerted on the liquid

10   to force it into the material. The force required to do this is minimal so the time the liquid sits on the surface is also minimal.

The system material must have increasing capillary tension in the Z-direction away from a wearer. As liquid moves through the material away from the wearer, the increasing capillary tension causes liquid to slow its Z-directional progress and results in horizontal

15   (X-Y directional) spreading within the system material. This horizontal spreading within the system material produces a greater wet contact area between the system material and the absorbent core, spreading out the absorbent load and so more efficiently using the core.

The system material is preferably a nonwoven fiber web and a number of variables

20   can be adjusted in order to control capillary tension in a nonwoven web; fiber size, density, hydrophilicity, pore size and fiber orientation are a few of these variables. The actual route chosen by one wishing to practice this invention will depend on the final product properties desired as well as the economics and manufacturing limitations faced at the time and are matters of choice well within the capabilities of one skilled in the art.

25   Whichever method or combination of methods is used, however, the wearer-facing surface must be hydrophobic and the capillary tension must increase in the Z-direction away from the wearer in order to produce a successful product according to this invention.

In the most preferred embodiment, the intake system material is produced as a single layer having a basis weight between about 13.6 gsm and 200 gsm and a thickness

30   between 0.2 mm and 15.0 mm. This material has the requisite hydrophobic surface and capillary tension gradient to function ideally. The economics of modern manufacturing, however, make this ideal, single layer material, unaffordable at the current time. A suitable alternative is to use multiple layers which have different capillary tensions than each other, and assemble them according to the requirements of the invention. When

35   multiple layers are used, the top layer closest to the wearer is referred to as the liner or top sheet and the subjacent layer is referred to as the surge layer. The liner and surge

layers may likewise be made of multiple layers.

One example for the top-most part of the system material is a multiple layer liner made, for example, according to US Patent application 09/209177, filed December 9, 1998 and co-assigned, where the top surface of the web is porous and ideally,

5 hydrophobic and the bottom surface of the web is porous and hydrophilic. The capillarity of the top layer should be lower than the other layers. The bottom hydrophilic layer helps pull the liquid from the hydrophobic layer into the next layer of the absorbent article. There must be liquid communication between the layers as well as between the liner and the next layer in the absorbent structure. This assures that proper draining of the top layer

10 occurs for minimal saturation. The combined basis weight of the liner webs may be between about 5 gsm and 50 gsm or more particularly between about 0.4 osy (13.6 gsm) and 0.7 osy (23.7 gsm).

The following are a control liner not meeting the requirements of the invention, and a suitable multi-layer liner. These materials were made according to processes well

15 known to those skilled in the art and could be reproduced by such individuals with minimal experimentation.

Control Liner

20 The control was a single layer, 0.5 osy (17 gsm), 2.2 denier polypropylene fiber spunbond web with a high density diamond point bonding pattern having a bond area of about 15 percent. The polypropylene used was Exxon Chemical's 3155, a Ziegler-Natta type polymer having a melt flow rate of about 35. The control also had a treatment of 0.3 weight percent AHCOVEL® surfactant on the top surface. The control had a bulk

25 thickness of 0.27 mm, a density of 0.062 g/cc, and a permeability of about 920 Darcies. This layer was tested for capillary tension according to the procedure given above and was found to be between 8 and 11 cm.

Liner Example

30 A two layer spunbond web was produced. The basis weight of the web was 0.5 osy with a ratio of 33:67 for the top to bottom layer basis weights. The top layer fibers had a denier of about 2.5 and were made from Exxon Chemical's 3155 polypropylene. The bottom layer fibers had a denier of about 5 and were also made from Exxon Chemical's 3155 polypropylene.

35 The bottom layer was treated with 0.3 weight percent AHCOVEL® surfactant available from ICI Chemicals and included 2 weight percent TiO_2 colorant as an internal
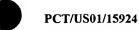
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additive to the fibers.

The layers were bonded using the EHP pattern described above.

The web so produced was tested according to the bulk, density and permeability methods. The bulk of the web was about 0.28 mm. The density was about 0.061 g/cc.

5 The permeability was about 1450 Darcies. This web was tested for capillary tension according to the procedure given above and an average of the two layers was found to be between 3 and 4 cm. The surface of the web was hydrophobic.

The layer immediately below the liner in the practice of the multi-layer embodiment of this invention is the surge layer. A surge layer is most typically interposed between and

10 in intimate, liquid communicating contact with the bodyside liner and a subjacent layer such as a distribution or absorbent core layer. To further enhance liquid transfer, it can be desirable to attach the upper and/or lower surfaces of the surge layer to the liner and the subjacent layer, respectively. Suitable conventional attachment techniques may be utilized, including, adhesive bonding (using water-based, solvent-based and thermally

15 activated adhesives), thermal bonding, ultrasonic bonding, needling and pin aperturing, as well as combinations of the foregoing or other appropriate attachment methods.

Surge layers are provided to quickly accept an incoming insult to reduce top surface pooling and runoff and keep the liquid within the structure once it is taken in. A surge layer in, for example, a diaper, must typically be capable of handling an incoming

20 insult of between about 60 and 100 cc at a volumetric flow rate of from about 5 to 20 cc/sec, for infants, for example. Examples of prior art surge layers may be found in US Patent 5,490,846 to Ellis et al. and in US Patent 5,364,382 to Latimer. As noted above, multiple layer surge materials may also be used in the practice of this invention.

The surge layer of this invention is preferably a single layer of fibers having a high

25 capillarity relative to the liner layer. The surge layer may have fibers in a diameter of from about 10 to 30 microns and the layer may be made from a blend of various diameter fibers or from homogeneous diameter fibers. If not inherently hydrophilic, the surge layer fibers may have a surfactant add-on level of between 0.05 and 3.0 weight percent, more particularly from about 0.1 and 1.0 weight percent, to make them hydrophilic. The

30 surfactant treatment may be internal or topical. Surge layers suitable for use in this invention preferably wick saline solution at least 100 mm and absorb at least 2 grams of saline when tested in accordance with the horizontal wicking test given above.

The following are a control surge not meeting the requirements of the invention, and a suitable surge layer. These materials were made according to processes well

35 known to those skilled in the art and could be reproduced by such individuals with minimal experimentation.

Control Surge

A bonded carded web was produced. The basis weight of the web was 2.5 osy.
The web was a mixture of 3 denier T-256 bicomponent fibers and 6 denier T-295
polyester fibers at a ratio of 60/40 respectively. Both fibers are commercially available
from KoSa Inc. The fibers were treated by the manufacturer with 0.3 weight percent of a
proprietary surfactant to make them hydrophilic.   The layers were produced according to
the carding process and then through air bonded.

The web so produced was tested according to a number of tests given above.
The bulk or caliper of the web was 3.7 mm, the density was 0.022 g/cc, the permeability
was 5350 Darcies and the horizontal wicking was 1.5 inches (38 mm) with 0.95 gms fluid
absorbed. This layer was tested for capillary tension according to the procedure given
above and it was found to be between 3 and 4 cm.

Surge Example

A bonded carded web was produced. The basis weight of the web was 2.5 osy.
The web was a mixture of 2 denier T-256 bicomponent fibers and 3 denier T-244
polyester fibers at a ratio of 60/40 respectively. Both fibers are commercially available
from KoSa Inc. The fibers were treated by the manufacturer with 0.5 weight percent of a
proprietary surfactant to make them hydrophilic.   The layers were produced according to
the carding process and then through air bonded.

The web so produced was tested according to a number of tests given above.
The bulk or caliper of the web was 3.2 mm, the density was 0.028 g/cc, the permeability
was 3300 Darcies and the horizontal wicking was 8 inches (203 mm) with 4.28 gms fluid
absorbed. It should be noted that this horizontal wicking distance is more than 5 times
that of the control surge. This layer was tested for capillary tension according to the
procedure given above and it was found to be between 5 and 8 cm.

The system material made from separate layers should have the layers bonded
sufficiently to hold the material together and to provide for liquid communication between
layers. Suitable conventional attachment techniques may be utilized, including, adhesive
bonding (using water-based, solvent-based and thermally activated adhesives), thermal
bonding, ultrasonic bonding, needling and pin aperturing, as well as combinations of the
foregoing or other appropriate attachment methods. If, for example, the surge layer is
adhesively bonded to the bodyside liner, the amount of adhesive add-on should be

sufficient to provide the desired level(s) of bonding, without excessively restricting the flow of liquid from the liner into the surge layer.

The TEWL testing referred to below used as a product a modified HUGGIES® ULTRATRIM® Step 4 diaper having about 12.8 grams of Stockhausen's (Charlotte, NC)

5   FAVOR® 880 superabsorbent mixed with 18 grams of pulp fluff placed in a zone about 94 mm wide. The standard liner top sheet and surge were replaced with the system to be tested wherein the tested liner covered the entire interior of the diaper and the tested surge was 73 mm wide and 220 mm long. A spacer layer was present between the outercover and absorbent layers and was a 0.6 osy (20.3 gsm)

10 spunbond/meltblown/spunbond laminate with a wire weave pattern, rectangular in shape with dimensions of 104 mm by 419 mm. The outercover was a 0.6 osy spunbond polypropylene web having a wire weave pattern, thermally bonded using a C-star pattern, to a film having a 12,000 Mocon breathability.

15   **Control Liner-Surge**

Control Surge was placed subjacent Control Liner resulting in a laminate where the top layer had a capillary tension of between 8 and 11 and the bottom layer had a capillary tension between 3 and 4. The webs were bonded by hand with adhesive in a

20 swirl pattern using about 0.03 grams of adhesive. This liner-surge laminate was tested for TEWL according to the above test method and the result was 25 $g/m^2/hr$.

Liner-Surge Example

Surge Example was placed subjacent Liner Example resulting in a laminate where the top layer had a capillary tension of between 3 and 4 and the bottom layer had a capillary tension between 5 and 8 or about twice that of the liner. The webs were bonded by hand with adhesive in a swirl pattern using about 0.03 grams of adhesive. This liner-surge laminate was tested for TEWL according to the above test method and the result was 17 $g/m^2/hr$.

The liner surge of this invention thus provides a greatly improved TEWL when compared to the Control liner surge. The inventors believe that such improvement should produce a reduction in TEWL of between 25 and 60 percent versus a liner not having a hydrophobic top surface and not having a capillary tension gradient increasing in the direction perpendicular to the top surface. Such an improvement in TEWL should result in healthier skin and reduced occurrences of diaper rash when used in a diaper.

Suitable system materials may be nonwoven webs made according to various processes known in the art including spunbonding, bonding and carding, and airlaying. The webs may be bonded according to known processes as well, including through air bonding, stitchbonding, ultrasonic bonding, point bonding, and pattern (or point) unbonding.

Polymers useful in the manufacture of the system materials of the invention include thermoplastic polymers like polyolefins, polyesters and polyamides. Elastic polymers may also be used and include block copolymers such as polyurethanes, copolyether esters, polyamide polyether block copolymers, ethylene vinyl acetates (EVA), block copolymers having the general formula A-B-A' or A-B like copoly(styrene/ethylene-butylene), styrene-poly(ethylene-propylene)-styrene, styrene-poly(ethylene-butylene)-styrene, (polystyrene/poly(ethylene-butylene)/polystyrene, poly(styrene/ethylene-butylene/styrene) and the like.

Polyolefins using single site catalysts, sometimes referred to as metallocene catalysts, may also be used. Many polyolefins are available for fiber production, for example polyethylenes such as Dow Chemical's ASPUN® 6811A linear low density polyethylene, 2553 LLDPE and 25355 and 12350 high density polyethylene are such suitable polymers. The polyethylenes have melt flow rates, respectively, of about 26, 40, 25 and 12. Fiber forming polypropylenes include Exxon Chemical Company's 3155 polypropylene and Montell Chemical Co.'s PF-304. Many other polyolefins are commercially available.

Biodegradable polymers are also available for fiber production and suitable polymers include polylactic acid (PLA) and a blend of BIONOLLE®, adipic acid and

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UNITHOX® (BAU). PLA is not a blend but a pure polymer like polypropylene. BAU represents a blend of BIONOLLE®, adipic acid, and UNITHOX® at different percentages. Typically, the blend for staple fiber is 44.1 percent BIONOLLE® 1020, 44.1 percent BIONOLLE® 3020, 9.8 percent adipic acid and 2 percent UNITHOX® 480, though

5   spunbond BAU fibers typically use about 15 percent adipic acid. BIONOLLE® 1020 is polybutylene succinate, BIONOLLE® 3020 is polybutylene succinate adipate copolymer, and UNITHOX® 480 is an ethoxylated alcohol. BIONOLLE® is a trademark of Showa Highpolymer Co. of Japan. UNITHOX® is a trademark of Baker Petrolite which is a subsidiary of Baker Hughes International. It should be noted that these biodegradable

10   polymers are hydrophilic and so are preferably not used for the surface of the inventive intake system materials.

The fibers used to produce the materials useful in this invention may be monocomponent, conjugate (bicomponent) or biconstituent fibers. If conjugate, they may have side-by-side, sheath/core or islands-in-the-stream configurations. The fibers may be

15   crimped or crimpable according to, for example, US Patent 5,382,400 to Pike.

As will be appreciated by those skilled in the art, changes and variations to the invention are considered to be within the ability of those skilled in the art. Such changes and variations are intended by the inventors to be within the scope of the invention.

What is claimed is:

1) An intake system material for personal care products comprising a nonwoven fiber web having a hydrophobic top surface, a bottom surface and a capillary tension gradient which increases in a direction perpendicular to said top surface.

2) The intake system material for personal care products of claim 1 having a TEWL level of between about 25 and 60 percent less than an intake material without a hydrophobic top surface and without a capillarity tension gradient which increases in a direction perpendicular to said top surface.

3) The intake system material of claim 1 wherein said intake system material has a basis weight between about 13.6 gsm and 200 gsm.

4) The intake system material of claim 1 wherein said bottom surface is hydrophilic.

5) The intake system material of claim 1 having a thickness between 0.2 mm and 15.0 mm.

6) The intake system material of claim 1 wherein said web comprises fibers made from polyolefin.

7) The intake system material of claim 6 wherein said polyolefin is selected from the group consisting of polyethylene, polypropylene, polybutylene and copolymers and blends thereof.

8) The intake system material of claim 1 that wicks saline solution at least 100 mm and absorbs at least 2 grams, according to a horizontal wicking test.

9) A liner and surge system for personal care products comprising at least a first liner layer having a top and bottom surface, and a surge layer, wherein;
said liner top surface is hydrophobic;
said surge layer has a capillary tension greater than said liner; and
said surge layer and said liner are joined together.

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10) The liner and surge system of claim 9 further comprising a second liner layer between said first liner layer and said surge and having a capillary tension greater than said first liner layer.

5   11) The intake system material for personal care products of claim 10 having a TEWL level of between about 25 and 60 percent less than an intake material without a hydrophobic top surface and without a capillarity tension gradient which increases in a direction perpendicular to said top surface.

10   12) The liner and surge system of claim 10 wherein said surge layer has a capillary tension about twice that of said liner.

13) The liner and surge system of claim 9 wherein said liner and surge layers are bonded together by a method selected from the group consisting of adhesive bonding thermal
15   bonding, ultrasonic bonding, needling and pin aperturing, and combinations thereof.

14) A liner and surge system for personal care products comprising:
       a liner having a basis weight between about 5 and 50 gsm and having two layers
       of fibers, a hydrophobic top layer facing a wearer and a bottom layer, the top layer
20   having fibers of a lower denier than the bottom layer, and;
       a surge layer having a capillary tension greater than said liner layer.

15) A diaper comprising the system of claim 1.

25   16) The diaper of claim 14 further comprising a breathable outercover.

17) A training pant comprising the system of claim 1.

18) An incontinence product comprising the system of claim 1.
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19) A bandage comprising the system of claim 1.

20) A sanitary napkin comprising the system of claim 1.